OVERVIEW AND R&D TEST PLANNING FOR THE JOINT U.S./ROK R&D AND TEST PROGRAM FOR NEW UNDERGROUND AMMUNITION STORAGE TECHNOLOGIES

Gary Abrisz, Director, U.S. Army Technical Center for Explosives Safety

NARRATIVE

COVER - 1

GOOD MORNING. I AM GARY W. ABRISZ THE ASSOCIATE DIRECTOR OF THE U.S. ARMY TECHNICAL CENTER FOR EXPLOSIVES SAFETY IN SAVANNA, ILLINOIS. I AM ALSO THE U.S. PROGRAM MANAGER FOR THE JOINT U.S./REPUBLIC OF KOREA RESEARCH, DEVELOPMENT, AND TEST PROGRAM TO DEVELOP NEW UNDERGROUND AMMUNITION STORAGE TECHNOLOGIES.

I WILL PRESENT TO YOU TODAY A BRIEF OVERVIEW OF THE PROGRAM AND THE ON-GOING AND PLANNED TEST ACTIVITIES. I WILL BE GLAD TO ANSWER YOUR QUESTIONS AT THE CONCLUSION OF THIS PRESENTATION. SHOULD YOU HAVE SPECIFIC QUESTIONS ON THE TEST PLANNING, WE WILL PRESENT THEM TO MR. KIM DAVIS THE U.S. TECHNICAL PROGRAM MANAGER. HE WILL BE GLAD TO ANSWER THOSE.

DR. SONG AND DR. LEE FROM THE REPUBLIC OF KOREA AGENCY FOR DEFENSE DEVELOPMENT ARE ATTENDING THIS SEMINAR AND I WILL BE GLAD TO REFER QUESTIONS YOU MAY HAVE RELATIVE TO THEIR ACTIVITIES TO THEM.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 1992		**00-00-1992 to 00-00-1992**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Overview and R&D Test Planning for the Joint U.S./ROK R&D and Test Program for New Underground	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Technical Center for Explosives Safety, ,Savanna,IL,61074**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADA260985, Volume II. Minutes of the Twenty-Fifth Explosives Safety Seminar Held in Anaheim, CA on 18-20 August 1992.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**55**	

- **PROGRAM MANAGERS**

ROK COLONEL JIN, SOO-JUN
EXPLOSIVES SAFETY MANAGEMENT BOARD, MND

U.S. MR. GARY W. ABRISZ
U.S. ARMY TECHNICAL CENTER
FOR EXPLOSIVES SAFETY

- **TECHNICAL MANAGERS**

ROK DR. SONG, SO-YOUNG
AGENCY FOR DEFENSE DEVELOPMENT

U.S. MR. L. KIM DAVIS
U.S. ARMY ENGINEER WATERWAYS
EXPERIMENT STATION

VUGRAPH 2

THE PROGRAM MANAGERS AND TECHNICAL PROGRAM MANAGERS ARE SHOWN ON THIS CHART. I WILL SHOW YOU A CHART LATER RELATING TO ALL THE PROGRAM'S RESPONSIBLE ORGANIZATIONS.

MY KOREAN COUNTERPART IS REPUBLIC OF KOREA ARMY COLONEL JIN, SOO-JUN. MR. L. KIM DAVIS, U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, IS THE U.S. PROGRAM'S TECHNICAL MANAGER. HIS KOREAN COUNTERPART IS DR. SONG, SO-YOUNG THE AGENCY FOR DEFENSE DEVELOPMENT IN TAEJON, KOREA.

PRESENTATION OUTLINE

- INTRODUCTION
- GOAL/OBJECTIVE
- ISSUE
- BACKGROUND
- RESPONSIBLE ORGANIZATIONS
- PLAN
- EXPECTED RESULTS
- CONCLUSION

VUGRAPH 3

THIS IS THE OUTLINE FOR MY PRESENTATION.

GOAL

- IDENTIFY, TEST, EVALUATE, AND DEMONSTRATE NEW UNDERGROUND AMMUNITION STORAGE DESIGN CONCEPTS

OBJECTIVE

- DESIGN TO REDUCE OR CONTROL EXTERNAL BLAST AND DEBRIS EFFECTS FROM AN ACCIDENTAL EXPLOSION UNDERGROUND

VUGRAPH 4

THE PROGRAM GOAL AND MAIN OBJECTIVE ARE STATED HERE. THE PROGRAM IS ESTABLISHED TO END WITH APPROVED NEW DESIGN CONCEPTS FOR APPLICATION WITHIN THE REPUBLIC OF KOREA WHICH SHOULD HAVE APPLICATIONS WORLDWIDE.

OVER THE LAST DECADE, A NUMBER OF EXPLOSIVE TESTS HAVE BEEN CONDUCTED TO INVESTIGATE THE HAZARDOUS EFFECTS THAT MAY BE PRODUCED BY ACCIDENTAL EXPLOSIONS IN UNDERGROUND MAGAZINES. THESE EFFECTS INCLUDE AIRBLAST, DEBRIS THROW, GROUND SHOCK, AND THE PROPAGATION OF AN EXPLOSION TO ADJACENT STORES OF AMMUNITION. THE TESTS PROVIDE EXPERIMENTAL DATA REQUIRED TO REFINE THE CURRENT DEPARTMENT OF DEFENSE (OR NORTH ATLANTIC TREATY ORGANIZATION) SAFETY STANDARDS, AND/OR TO EVALUATE NEW DESIGN FEATURES FOR UNDERGROUND MAGAZINES.

NEW CONCEPTS FOR UNDERGROUND MAGAZINES ARE PRESENTLY BEING EVALUATED, EITHER TO PROVIDE NEW STORAGE CAPABILITIES, OR TO DRASTICALLY REDUCE THE PRESENT HAZARD RANGES FOR UNDERGROUND AMMUNITION STORAGE. IN SPITE OF THE TREMENDOUS ADVANCES IN OUR ABILITY TO MATHEMATICALLY SIMULATE THE COMPLEXITIES OF MAGAZINE EXPLOSIONS USING COMPUTER MODELS, SMALL-SCALE EXPLOSIVE TESTS CONTINUE TO BE AN INVALUABLE SOURCE OF DATA AND INSIGHTS. THE JOINT U.S./REPUBLIC OF KOREA RESEARCH AND DEVELOPMENT PROGRAM FOR NEW UNDERGROUND AMMUNITION STORAGE TECHNOLOGIES, TO BE CONDUCTED OVER THE NEXT 5 YEARS, WILL

VUGRAPH 4 (CONT)

INVOLVE EXTENSIVE SMALL-SCALE AND INTERMEDIATE-SCALE TESTING TO INVESTIGATE, EVALUATE, AND DOWN-SELECT PROMISING DESIGN FEATURES THAT SHOULD ENABLE US TO GREATLY REDUCE THE EXTERNAL HAZARDS FROM AN UNDERGROUND MAGAZINE. OUR DIRECT EMPHASIS HAS BEEN ON OUR STORAGE IN THE REPUBLIC OF KOREA.

ISSUE

- U.S./ROK AGREEMENTS REQUIRE APPLICATION OF THE U.S. DOD AMMUNITION AND EXPLOSIVES SAFETY STANDARDS

- SERIOUS QUANTITY DISTANCE (QD) VIOLATIONS EXIST IN ROK

- PERMIT A REALISTIC USE OF U.S./ROK TECHNICAL CAPABILITIES TO REDUCE QD REQUIREMENTS IN THE ROK AND THE U.S.

ISSUE NARRATIVE

VUGRAPH 5

THE ISSUE THE DEPARTMENT OF DEFENSE WAS FACING IN KOREA IN THE MID 1980s AND CONTINUES TO RECOGNIZE, IS WHAT HAS GENERATED THIS OFFICE OF THE SECRETARY OF DEFENSE-DIRECTED AND ARMY MANAGED PROGRAM. THE STORAGE OF U.S. DEPARTMENT OF DEFENSE AMMUNITION IN KOREA RELATES TO APPLICATION OF U.S. EXPLOSIVES SAFETY STANDARDS.

THE SITUATION IS CURRENTLY THAT THE STANDARDS CAN NOT BE ACCOMMODATED TO THE FULL EXTENT AND MANY VIOLATIONS AND EXPOSURES RESULT.

THIS RESEARCH AND DEVELOPMENT EFFORT AS STATED IS TO DETERMINE THE USE OF NEW TECHNICAL APPLICATIONS TO REDUCE QUANTITY DISTANCE REQUIREMENTS.

THE MEMORANDUM OF AGREEMENT AND THE ASSOCIATED STATEMENT OF WORK ARE DIRECTED TOWARD THIS ISSUE. THEY ARE INTENDED TO DESIGN CONCEPTS TO ELIMINATE THE EXISTING SERIOUS EXPLOSIVES SAFETY VIOLATIONS IN THE REPUBLIC OF KOREA AS WELL AS THROUGHOUT THE DEPARTMENT OF DEFENSE STORAGE COMPLEX.

ESSENCE OF THE ISSUE

- TRADE-OFFS BETWEEN:
  - •• SAFETY - BUFFER ZONES TO COMPLY WITH SAFETY STANDARDS
  - •• OPERATIONAL CAPABILITY - AMMUNITION TO MEET ARMY/NAVY/USAF MISSIONS
  - •• COST INVESTMENT - LAND FOR BUFFER ZONES ($10,000 TO $100,000 PER ACRE)

VUGRAPH 6

DISCUSSING THE ISSUE IN KOREA IN MORE DETAIL RELATES TO MANY SITUATIONS AT THE AMMUNITION STORAGE SITES WHICH FORCE US TO MAKE TRADE-OFFS BETWEEN SAFETY, OPERATIONAL REQUIREMENTS, AND COST INVESTMENT.

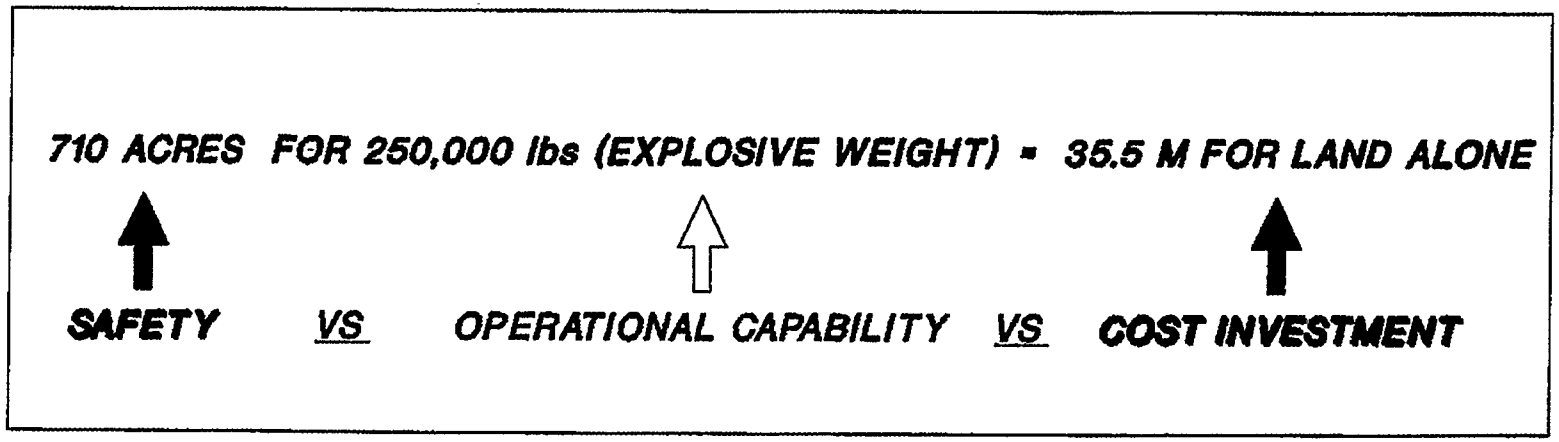
THE DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY STANDARDS REQUIRE QUANTITY DISTANCE ZONES OR BUFFER ZONES TO PROTECT AREAS EXTERNAL TO OUR SITES AS YOU ARE AWARE. MANY TIMES IN AREAS SUCH AS KOREA, OUR MISSION REQUIRES QUANTITIES OF AMMUNITION WHICH VIOLATE THE STANDARDS.

THE COST OF REAL ESTATE IN HIGHLY POPULATED REGIONS FOR USE AS THE REQUIRED BUFFER ZONES BECOMES PROHIBITIVE. THEREFORE, THE NEED TO REDUCE THE ZONES AND SATISFY SAFE STORAGE BECOMES PARAMOUNT.

ESSENCE OF THE ISSUE

EXAMPLE:

CONSIDER $50,000/ACRE. - A TYPICAL EARTH-COVERED MAGAZINE REQUIRES:



ESSENCE OF THE ISSUE NARRATIVE

VUGRAPH 7

THIS IS AN EXAMPLE TO CONSIDER.

AT $50K AVERAGE PER ACRE A TYPICAL STORAGE SITUATION RELATING TO AN ABOVEGROUND EARTH-COVERED MAGAZINE WOULD REQUIRE $35.5M OF INVESTMENT TO PURCHASE REAL ESTATE REQUIRED WITHIN THE QUANTITY DISTANCES BUFFER ZONE. THIS IS IF ONE CAN CONSIDER THE REAL ESTATE IS AVAILABLE FOR PURCHASE. IN MANY INSTANCES IN KOREA ACQUISITION IS IMPROBABLE AT BEST.

BACKGROUND

SEP 1987 - DDESB EXPLOSIVES SAFETY SURVEY IDENTIFIED VIOLATIONS AND CONCERNS

AUG 1988 - U.S. DOD AND ROK MND ESTABLISHED A JOINT TECHNICAL WORKING GROUP

MAR 1989 - SEVEN PROPOSED STORAGE CONCEPTS WERE EVALUATED

VUGRAPH 8

WITH THAT AS THE ISSUE, I WOULD LIKE TO NOW QUICKLY COVER THE BACKGROUND RELATIVE TO THE PROGRAM DEVELOPMENT. BEGINNING IN THE 1985 AND 1987 TIME PERIOD WHEN THE VIOLATIONS IN KOREA WERE FIRST DOCUMENTED BY THE DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD, OUR DEPARTMENT OF DEFENSE AND REPUBLIC OF KOREA MINISTRY OF NATIONAL DEFENSE DIRECTED ESTABLISHMENT OF A TECHNICAL WORKING GROUP TO RESOLVE THE ISSUE.

SEVERAL PROPOSALS WERE GENERATED AND WERE EVALUATED BY THE GROUP MADE UP OF REPRESENTATIVES OF DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD, U.S. ARMY, U.S. NAVY, U.S. AIR FORCE, AND REPUBLIC OF KOREA MINISTRY OF NATIONAL DEFENSE.

THE UNDERGROUND STORAGE CONCEPT PRESENTED BY WATERWAYS EXPERIMENT STATION AT THAT TIME WAS SELECTED AMONG THE VARIOUS SERVICE CONCEPTS PRESENTED. THE MOUNTAINOUS TERRAIN AND GRANITE ROCK GEOLOGY IN KOREA ADAPTS WELL TO THIS UNDERGROUND CONCEPT.

BACKGROUND

JUL 1989 - U.S./ROK STATEMENT OF INTENT

FEB 1990 - UNDERGROUND STORAGE CONCEPT SELECTED

MAR 1990 - A JOINT R&D PLAN RESULTED IN A DRAFT MOA

VUGRAPH 9

THE U.S./REPUBLIC OF KOREA SIGNED A STATEMENT OF INTENT TO ENTER INTO AN AGREEMENT IN JULY 1989.

A DRAFT MEMORANDUM OF AGREEMENT WAS DEVELOPED IN MARCH OF 1990.

BACKGROUND

APR 1990 - CANDIDATE FOR NUNN AMENDMENT COOPERATIVE R&D PROGRAM FUNDS

MAY 1990 - DRAFT MOA TO HQDA AND OSD FOR STAFFING

- PROJECT IDENTIFIED FOR HQDA FUNDING FY 94 AND FY 95

NOV 1990 - CERTIFIED BY OUSD(A) (NUNN $)

VUGRAPH 10

IN 1990 ALSO, HEADQUARTERS, DEPARTMENT OF THE ARMY IDENTIFIED PROGRAM FUNDING FOR OUTYEARS. THE PROGRAM WAS CERTIFIED BY OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR ACQUISITION AS AN APPROVED CANDIDATE FOR THE U.S. CONGRESSIONAL NUNN AMENDMENT COOPERATIVE RESEARCH AND DEVELOPMENT PROGRAM FUNDING IN NOVEMBER OF THAT YEAR. A TOTAL OF $9.5M WAS PROGRAMMED. THE REPUBLIC OF KOREA HAS PROGRAMMED $3.5M FOR THEIR EFFORT.

BACKGROUND

JAN 1991 - OUSD(A) AUTHORITY TO NEGOTIATE AND CONCLUDE MOA

APR 1991 - MOA NEGOTIATIONS AND AGREEMENT

JUL-AUG 1991 - MOA SIGNED

AUG 1991 - NUNN FUNDS RELEASE - R&D COMMENCES

VUGRAPH 11

A WHOLE SERIES OF NEGOTIATIONS TOOK PLACE AND A MEMORANDUM OF AGREEMENT AND STATEMENT OF WORK RESULTED IN AN AGREEMENT IN 1991. THE FUNDING WAS PROVIDED AND OUR RESEARCH AND DEVELOPMENT EFFORTS GOT UNDERWAY.

RESPONSIBLE ORGANIZATIONS

	U.S.	ROK
PROPONENT:	CG, COMBINED FORCES COMMAND AND U.S. FORCES, KOREA (USFK)	MINISTRY OF NATIONAL DEFENSE (MND)
DIRECTING OFFICE:	OFFICE OF THE UNDER SECRETARY OF DEFENSE (ACQUISITION)	MND DIRECTOR, LOGISTICS BUREAU
REGULATORY AGENCY:	DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD	MND EXPLOSIVES SAFETY MANAGEMENT BOARD
PROGRAM MGMT:	U.S. ARMY TECHNICAL CENTER FOR EXPLOSIVES SAFETY	MND EXPLOSIVES SAFETY MANAGEMENT BOARD
R&D LEAD LAB:	USACE WATERWAYS EXPERIMENT STATION	AGENCY FOR DEFENSE DEVELOPMENT (ADD)

RESPONSIBLE ORGANIZATIONS

VUGRAPH 12

I MENTIONED EARLIER I WOULD SHOW THE RESPONSIBLE ORGANIZATIONS.

THIS EFFORT WAS DRIVEN BY THE 20TH SECURITY CONSULTATIVE MEETING AT OUR SECRETARY OF DEFENSE LEVEL AND THE REPUBLIC OF KOREA MINISTRY OF NATIONAL DEFENSE LEVEL. WE ENJOY A HIGH VISIBILITY AND EQUAL SUPPORT.

WE EXPECT THE PROGRAM TO RESULT IN NEW CRITERIA FOR UNDERGROUND AMMUNITION STORAGE WHICH WILL BE REVIEWED AND APPROVED BY THE U.S. DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD AND THE REPUBLIC OF KOREA MINISTRY OF NATIONAL DEFENSE EXPLOSIVES SAFETY MANAGEMENT BOARD AS THE REGULATORY AGENCIES SHOWN HERE. BOTH ORGANIZATIONS ARE DIRECTLY INVOLVED IN THE RESEARCH AND DEVELOPMENT AND TEST PROCESSES AND EVALUATIONS AS WE PROCEED.

U.S. TECHNICAL ADVISORY GROUP (TAG)

PURPOSE: ADVISE THE PROGRAM MANAGERS (PMs) AND TECHNICAL MANAGERS ON THE NEW UNDERGROUND AMMUNITION STORAGE TECHNOLOGIES (UAST) PROGRAM ACTIVITIES AND CONCEPTS

U.S. MEETINGS -	NOV 91	WES	VICKSBURG, MS
	JUN 92	WES	VICKSBURG, MS
ROK MEETING -	MAY 92	TAEJON, KOREA	

U.S. TECHNICAL ADVISORY GROUP

VUGRAPH 13

BOTH THE U.S. AND REPUBLIC OF KOREA HAVE ESTABLISHED TECHNICAL ADVISORY GROUPS. WE AGREED TO DO THIS IN OUR MEMORANDUM OF AGREEMENT NEGOTIATIONS. THIS CHART SHOWS OUR TECHNICAL ADVISORY GROUP PURPOSE AND PAST MEETINGS. A CHARTER HAS BEEN DEVELOPED AND INCORPORATED INTO THE PROGRAM DOCUMENTS.

THE U.S. HAS HAD TWO MEETINGS AND THE REPUBLIC OF KOREA HAS HAD ONE. REPUBLIC OF KOREA REPRESENTATIVES ATTENDED THE FIRST U.S. MEETING AT WATERWAYS EXPERIMENT STATION AND U.S. REPRESENTATIVES ATTENDED THE FIRST REPUBLIC OF KOREA MEETING AT THE AGENCY FOR DEFENSE DEVELOPMENT IN TAEJON, REPUBLIC OF KOREA THIS YEAR. OUR NEXT U.S. MEETING IS SCHEDULED FOR THE FIRST WEEK OF DECEMBER 1992 AT SOCORRO, NEW MEXICO.

U.S. TAG MEMBERSHIP

ORGANIZATION	NAME
DDESB SECRETARIAT	DR. CHESTER E. CANADA
USAF:	
AFSA	MR. PAUL D. PRICE, P.E.
U.S. ARMY:	
CEHND	MR. PAUL LAHOUD
BRL	MR. ONA R. LYMAN
AMC DCS AMMO	MR. ROBERT J. FAHY
U.S. NAVY:	
NSWC	MR. MICHAEL M. SWISDAK
NCEL	MR. JAMES E. TANCRETO
KOREA:	
U.S., USFK J4	COLONEL TOMMERVIK

VUGRAPH 14

YOU SEE MANY FAMILIAR NAMES ON THIS CHART.

THIS MEMBERSHIP REPRESENTS MUCH OF THE EXPLOSION EFFECTS EXPERTISE WITHIN THE U.S. DEPARTMENT OF DEFENSE. THE U.S. ARMY MATERIEL COMMAND DEPUTY CHIEF OF STAFF FOR AMMUNITION AND U.S. FORCES, KOREA, J4, REPRESENT THE LOGISTICS INPUT AND THE USER REQUIREMENT CONSIDERATIONS IN THIS CONCEPT DEVELOPMENT. AS A MEMBER OF THE DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD SECRETARIAT, DR. CANADA PROVIDES THE CHAIRMANSHIP IN SUPPORT OF THE PROGRAM AND TECHNICAL MANAGERS.

THE REPUBLIC OF KOREA HAS AN EQUALLY QUALIFIED AND AN IMPRESSIVE GROUP OF EXPERTS TO REVIEW THEIR ACTIVITIES AND COORDINATE WITH THIS U.S. GROUP OF EXPERTS. WE HAVE BEEN VERY MUCH IMPRESSED BY THEIR ACTIVITIES AND RESULTS.

PLAN

- FIVE PHASES OF WORK, OVER FIVE-YEAR PERIOD:
  - CY 91 - PHASE 1: R&D PLANNING AND PREPARATION
  - CY 92 - PHASE 2: SMALL-SCALE TEST PROGRAM
  - CY 93 - PHASE 3: INTERMEDIATE-SCALE INVESTIGATIONS
  - CY 94 - PHASE 4: VALIDATION TESTS
  - CY 95 - PHASE 5: FINAL CONCEPT DESIGNS (AND PORTION OF CY 96)

NARRATIVE FOR PLAN

VUGRAPH 15

THIS CHART SIMPLY SHOWS THAT THE PROGRAM HAS BEEN PLANNED OUT OVER A FIVE PHASE PERIOD. THE STATEMENT OF WORK REFLECTS THIS. THE FACT THAT WE STARTED WITH FUNDING ORIGINALLY INTENDED FOR 1990 IN EARLY SEPTEMBER 1991, MEANS THAT THE FIVE PHASE PROGRAM WILL NOW EXTEND INTO 1996. THE ORGANIZATION OF THE PROGRAM RELATES TO THE INITIAL PLANNING AND PREPARATION THROUGH SMALL-SCALE TESTING INTO INTERMEDIATE TESTS AND THEN MUCH LARGER VALIDATION TESTS. THESE WILL PROBABLY OCCUR IN PLACES LIKE SOCORRO, NEW MEXICO AND CHINA LAKE, CALIFORNIA. ALL OF THE PHASES ARE FOR THE PURPOSE OF CULMINATING IN FINAL CONCEPT DESIGNS THAT CAN BE APPROVED BY BOTH THE REPUBLIC OF KOREA EXPLOSIVES SAFETY MANAGEMENT BOARD AND THE U.S. DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD. I WILL SPEAK IN GENERAL TO THE RESEARCH AND DEVELOPMENT PLANNING AND TESTING WITH THE FOLLOWING CHARTS.

PHASE 1. R&D PLANNING AND PREPARATION

- DESIGNATE TECHNICAL PROGRAM MANAGERS AND ORGANIZE RESEARCH TEAMS
- ESTABLISH TECHNICAL ADVISORY GROUP
- LITERATURE SEARCH
- IDENTIFY AND SELECT COMPUTER CODES FOR ANALYSIS OF MAGAZINE DESIGNS (E.G., SPIDS, SHARC, AB-HULL, BLASTIN)
- OBTAIN GAGES AND OTHER TEST EQUIPMENT
- IDENTIFY PROMISING TECHNIQUES FOR REDUCTION OF PRESSURE/IMPULSE FROM EXPLOSIONS IN UNDERGROUND MAGAZINES: DESIGN SMALL-SCALE TEST PROGRAM

VUGRAPH 16

PHASE 1 HAS BEEN COMPLETED ACCOMPLISHING THE ACTIONS ON THIS CHART. I HAVE MENTIONED THE PROGRAM MANAGERS AND THE U.S. AND REPUBLIC OF KOREA TECHNICAL PROGRAM MANAGERS WERE ESTABLISHED TO PLAN THIS COORDINATED REPUBLIC OF KOREA/U.S. RESEARCH AND DEVELOPMENT PROGRAM. THE LEAD LABS IN REPUBLIC OF KOREA (AGENCY FOR DEFENSE DEVELOPMENT) AND U.S. (WATERWAYS EXPERIMENT STATION) ARE RESPONSIBLE FOR ACCOMPLISHING THESE TECHNICAL ACTIVITIES.

WE RECRUITED MEMBERS FROM ORGANIZATIONS WITH EXPERTISE RELATED TO RESEARCH AND DEVELOPMENT OBJECTIVES, TO ADVISE ON RESEARCH AND DEVELOPMENT PROGRAM PROGRESS AS A TECHNICAL ADVISORY GROUP, AS I DISCUSSED PREVIOUSLY.

WE HAVE ASSEMBLED PERTINENT DOCUMENTS THROUGH A LITERATURE SEARCH. WE CONTINUE TO ANALYZE EXISTING RESEARCH AND DEVELOPMENT INFORMATION TO IDENTIFY PRESENT TECHNOLOGY FOR PREDICTION AND CONTROL OF EXPLOSION HAZARDS FOR UNDERGROUND MAGAZINES.

AREAS OF EMPHASIS IN THE SEARCH CATEGORIES HAVE BEEN:

- AIRBLAST PRESSURE/IMPULSE EFFECTS INTERNALLY, AT THE EXIT, AND EXTERNAL TO THE PORTAL.

VUGRAPH 16 (CONT)

- WE ARE CONSIDERING CHAMBER SEPARATION (WITH RESPECT TO SYMPATHETIC DETONATION FROM AIRBLAST, GROUND SHOCK, AND SPALLING OF ADJACENT WALL).

WE ARE LOOKING AT INFORMATION AND DATA ON:

- BUFFER/BAFFLED STORAGE SYSTEMS (TO REDUCE SYMPATHETIC DETONATIONS).
- GROUND SHOCK HAZARDS (FREE FIELD).
- EJECTA DEBRIS HAZARDS AND DEBRIS TRANSPORT MECHANICS (IN TUNNEL AND EXTERNAL).
- AND ALSO IDENTIFYING PERTINENT DATA FROM SHOCK TUBES AND LARGE GUN TESTS.

WATERWAYS EXPERIMENT STATION AND THE AGENCY FOR DEFENSE DEVELOPMENT CONTINUE TO:

- EVALUATE CODE CAPABILITIES AND LIMITATIONS.
- THEY HAVE TRAINED RESEARCH TEAMS IN USE OF SELECTED CODES.
- THEY ARE VERIFYING CODES AGAINST EXISTING EXPERIMENTAL DATA.
- WATERWAYS EXPERIMENT STATION HAS OBTAINED BLAST PRESSURE GAGES AND DATA RECORDING EQUIPMENT NEEDED FOR EXPLOSIVE TESTING (SMALL-SCALE) IN THE ON-GOING PHASE 2.
- THEY ARE EVALUATING DATA ON EFFECTS OF LOADING DENSITY (BASED ON CHAMBER VOLUME AND TOTAL VOLUME).

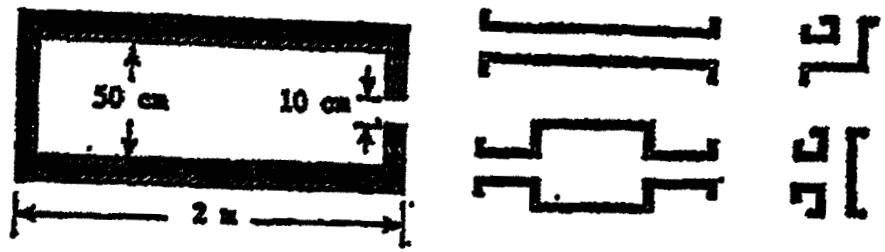
PHASE 2 SMALL-SCALE TEST PROGRAM

- CONSTRUCTION OF SMALL-SCALE TEST FACILITIES (U.S. AND ROK)
- CONDUCT SMALL-SCALE EXPLOSIVE TEST PROGRAM
- COMPUTER MODEL STUDIES OF CHAMBER/TUNNEL DESIGN PERFORMANCE
- EVALUATE RESULTS OF SMALL-SCALE TESTS AND COMPUTER MODEL STUDIES
- SELECT BEST DESIGN FEATURES FOR FURTHER STUDY

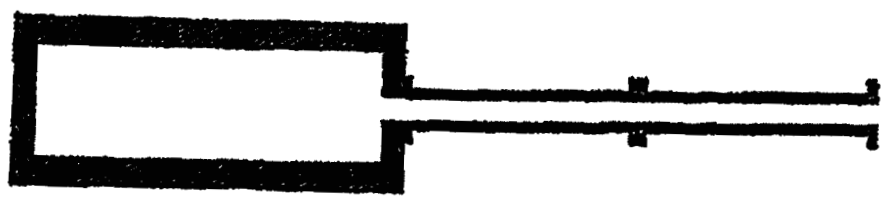
PHASE 2 NARRATIVE

VUGRAPH 17

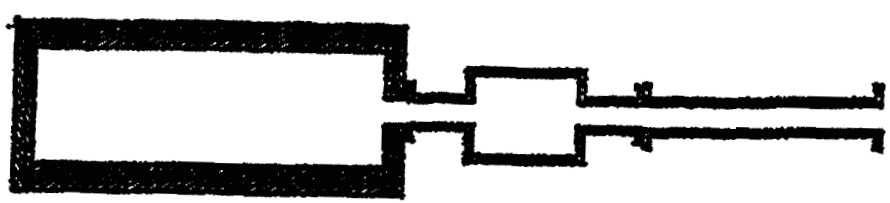
A SERIES OF SMALL-SCALE MODEL TESTS ARE BEING CONDUCTED BY WATERWAYS EXPERIMENT STATION AND THE AGENCY FOR DEFENSE DEVELOPMENT IN THE REPUBLIC OF KOREA.



a. Blast chamber and pipe (tunnel) components.



b. Assembly to investigate effect of tunnel lengths.

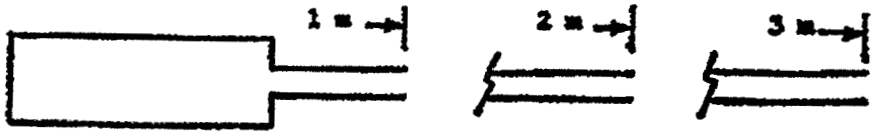


c. Assembly to investigate effect of an expansion chamber.

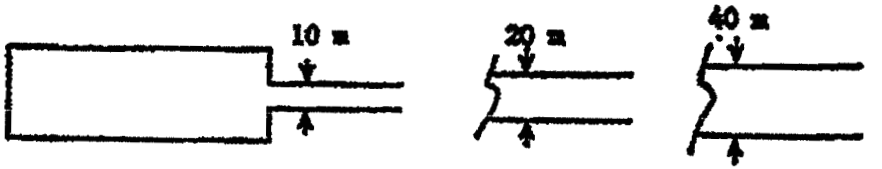
VUGRAPH 17A

WATERWAYS EXPERIMENT STATION IS USING A STEEL DETONATION CHAMBER FABRICATED IN THE WATERWAYS EXPERIMENT STATION SHOPS. THE U.S. CHAMBER IS 2 METERS LONG WITH AN INTERNAL DIAMETER OF 50 CM AND A WALL THICKNESS OF 15.25 CM. THE CHAMBER VOLUME IS 0.365 M^3 (12.885 $FEET^3$).

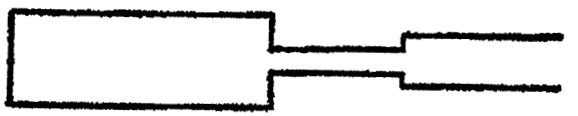
VARIOUS CONFIGURATIONS OF STEEL PIPE ARE ATTACHED TO THE DETONATION CHAMBER TO INVESTIGATE UNDERGROUND MAGAZINE DESIGN PARAMETERS.



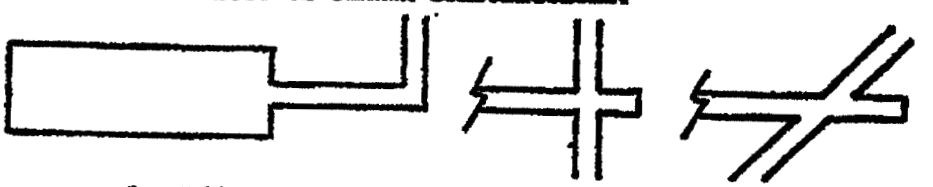
a. Effect of tunnel length.



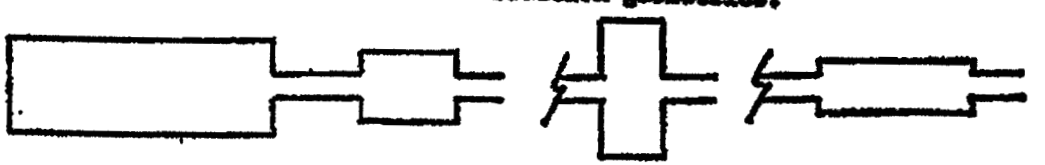
b. Effect of tunnel/chamber diameter ratios.



c. Effect of tunnel constrictions.



d. Effect of tunnel intersection geometries.

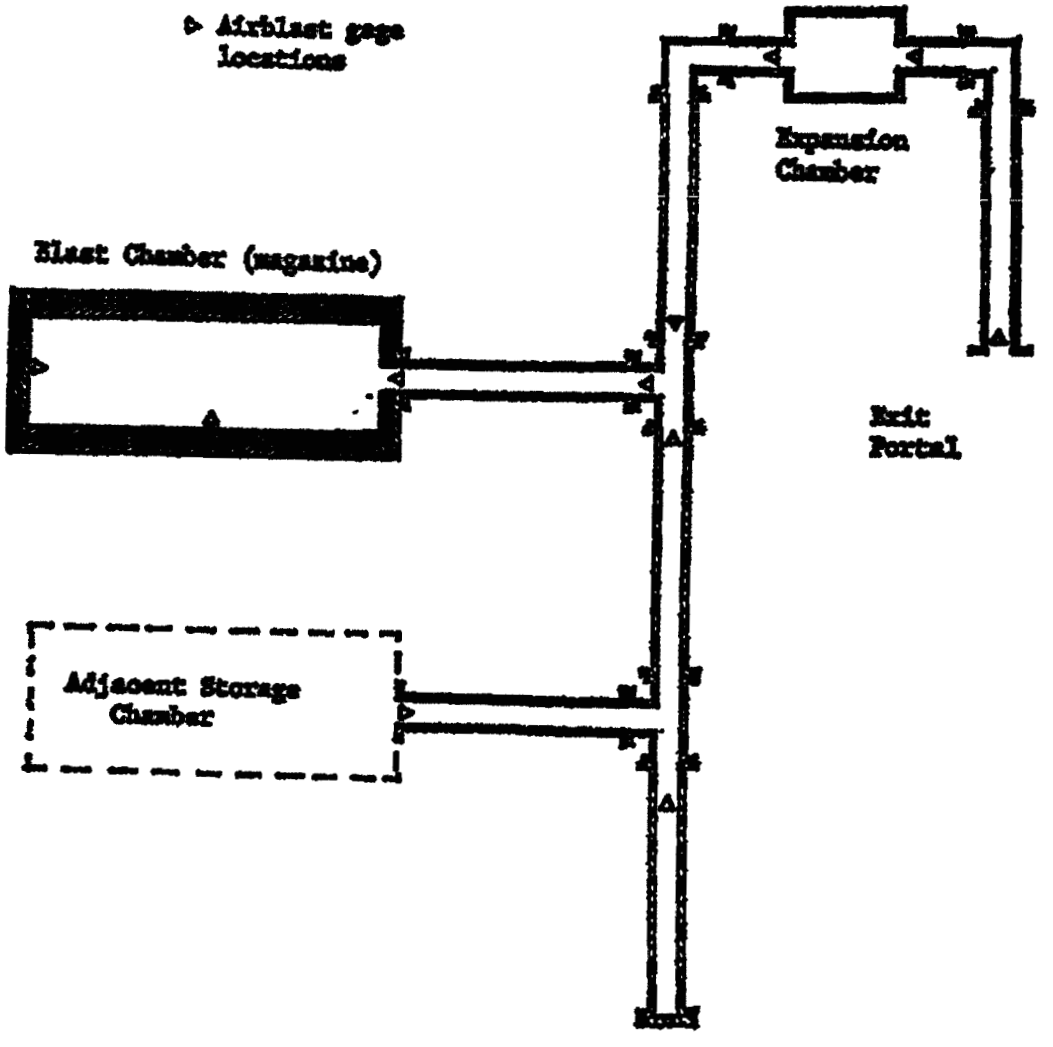


e. Effect of expansion chamber geometries.

f. Effect of offset expansion chamber exits.

VUGRAPH 17B

THE GENERIC MODEL TESTS WILL EVALUATE THE EFFECTS OF; (1) TUNNEL LENGTH, (2) TUNNEL/CHAMBER DIAMETER RATIO, (3) TUNNEL VOLUME, (4) TUNNEL CONSTRICTIONS, (5) TUNNEL INTERSECTION GEOMETRY, (6) EXPANSION CHAMBER GEOMETRY, (7) MULTIPLE TUNNEL EXITS,


Airblast gage locations
Expansion Chamber
Blast Chamber (magazine)
Exit Portal
Adjacent Storage Chamber

VUGRAPH 17C

AND (8) COMPLEX TUNNEL LAYOUTS.

PHASE 2 SMALL-SCALE TEST PROGRAM

- CONSTRUCTION OF SMALL-SCALE TEST FACILITIES (U.S. AND ROK)
- CONDUCT SMALL-SCALE EXPLOSIVE TEST PROGRAM
- COMPUTER MODEL STUDIES OF CHAMBER/TUNNEL DESIGN PERFORMANCE
- EVALUATE RESULTS OF SMALL-SCALE TESTS AND COMPUTER MODEL STUDIES
- SELECT BEST DESIGN FEATURES FOR FURTHER STUDY

VUGRAPH 18

THE CHAMBER IS BEING INSTRUMENTED FOR GAS PRESSURE, TEMPERATURE, AND THERMAL FLUX. GAS PRESSURE MEASUREMENTS ARE MADE WITH GAGES MOUNTED AT THE OUTER END OF THREE HOLES DRILLED THROUGH THE SIDE WALL OF THE CHAMBER AT POINTS 45 CM FROM EACH END AND AT THE MID-LENGTH. THERMAL GAGES (A THERMAL-FLUX GAGE AND THERMOCOUPLE) ARE MOUNTED IN THE REAR WALL OF THE CHAMBER.

ADDITIONALLY WE ARE LOOKING AT:

- THE EFFECTIVENESS OF DEBRIS TRAPS AND BARRICADES FOR DETONATION DEBRIS CONTAINMENT.

- ALSO OPERATION AND EFFECTIVENESS OF TUNNEL CLOSURE SYSTEMS NEAR TUNNEL EXITS (LOW PRESSURE REGION) WILL BE STUDIED.

IN THE REPUBLIC OF KOREA, THE AGENCY FOR DEFENSE DEVELOPMENT HAS CONSTRUCTED FACILITIES ALSO. THE TESTS BY BOTH THE WATERWAYS EXPERIMENT STATION AND AGENCY FOR DEFENSE DEVELOPMENT ARE PLANNED TO COMPLEMENT EACH OTHER IN VERIFYING RESULTS. THE REPUBLIC OF KOREA PROGRAM RELATES TO A SIMILAR CHAMBER AND PIPING APPLICATION.

FOR INTERMEDIATE-TO-HIGH LOADING DENSITIES (20 TO 100 KG/M^3) THE PLANS ARE TO EVALUATE:

VUGRAPH 18 (CONT)

- THE EFFECT OF CHAMBER LOADING DENSITY ON TUNNEL ENTRY PRESSURES.

- THE EFFECT OF RATIOS OF CHAMBER CROSS-SECTION TO TUNNEL CROSS-SECTION, AND CHAMBER VOLUME TO TUNNEL CROSS-SECTION, ON TUNNEL ENTRY PRESSURES.

- THE CONTRIBUTION OF GAS PRESSURE "JETTING" ON EXTERNAL BLAST PRESSURES FROM DETONATIONS AT HIGH LOADING DENSITIES.

- THE EFFECT OF STEEP TOPOGRAPHIES FOR CONTROLLING EXTERNAL BLAST EFFECTS.

- THE EFFECT OF CHAMBER SPACINGS (IN ROCK) ON DAMAGE TO "ACCEPTOR" CHAMBERS.

- THE EFFECTIVENESS OF "SELF-SEALING" CHAMBER DESIGNS AND BLAST-ACTIVATED CHAMBER PLUGS FOR CONTAINMENT OF BLAST PRESSURES IN THE HIGH-PRESSURE REGION.

COMPUTER MODEL STUDIES ARE ON-GOING IN THE U.S. AND REPUBLIC OF KOREA:

THIS INCLUDES IN THE U.S. THE:

- INVESTIGATION OF CHAMBER SELF-SEALING CONCEPTS WITH SHARC HYDROCODE.

- DETERMINING MINIMUM ROCK COVER DEPTHS OVER CHAMBERS FOR DETONATIONS OF DIFFERENT LOADING DENSITIES, FOR DIFFERENT ROCK PROPERTIES, USING SHARC AND UNIVERSAL DISCRETE ELEMENT CODE.

- DETERMINING DEBRIS EJECTION VELOCITIES FROM CHAMBERS AND ACCESS TUNNELS,

VUGRAPH 18 (CONT)

EVALUATING DEBRIS CONTROL WITH BLAST TRAPS (IN TUNNELS) AND EXTERNAL BARRICADES, USING SHARC AND UNIVERSAL DISCRETE ELEMENT CODE.

- ALSO DETERMINING DYNAMIC GAS FLOW PRESSURE HISTORIES FOR ACTIVATION OF TUNNEL CLOSURE SYSTEMS.

ALSO IN THE REPUBLIC OF KOREA THEY ARE:

- CALCULATING STRESS LOADS TRANSMITTED THROUGH ROCK TO "ACCEPTOR" CHAMBERS FROM "DONOR" CHAMBER DETONATIONS, AS FUNCTION OF ROCK TYPES AND CHAMBER SPACINGS.

- THEY ARE DETERMINING PRESSURE HISTORIES AS FUNCTION OF LOADING DENSITIES, TUNNEL LENGTHS, AND TUNNEL LAYOUT GEOMETRIES, USING HULL AND SHARC CODES.

- ALSO THEY ARE DETERMINING TUNNEL PRESSURE REDUCTIONS FROM EXPANSION CHAMBERS AND TUNNEL CONSTRICTIONS, USING HULL AND SHARC CODES.

PHASE 2 IN THE U.S. IS EXPECTED TO BE COMPLETED IN DECEMBER THIS YEAR. THE REPUBLIC OF KOREA EFFORT MAY CONTINUE A FEW MONTHS INTO 1993.

BASED ON THE EVALUATIONS BY EACH LEAD LAB (AGENCY FOR DEFENSE DEVELOPMENT AND WATERWAYS EXPERIMENT STATION) AND THE RECOMMENDATIONS OF THE TECHNICAL ADVISORY GROUPS THE U.S. AND REPUBLIC OF KOREA TECHNICAL PROGRAM MANAGERS

VUGRAPH 18 (CONT)

WILL IDENTIFY THE MOST PROMISING DESIGN FEATURES (OF THOSE INVESTIGATED IN PHASE 2) FOR FURTHER INVESTIGATION IN PHASE 3.

PHASE 3 INTERMEDIATE-SCALE TEST PROGRAM

- DESIGN WILL BE A DIRECT RESULT OF PHASE 2 TESTING PROGRAM

  - U.S. IS PLANNING TO USE EXISTING MINES WITH MODIFICATIONS IN NEW MEXICO

  - ROK HAS GEO-A ISLAND JUST OFF THE PENINSULA

NARRATIVE PHASE 3

VUGRAPH 19

THE TEST OBJECTIVES AND TEST PLANS FOR 1/6 AND 1/8-SCALE INTERMEDIATE EXPLOSIVE TESTS VARY FROM 10 KG TO 500 KG. FURTHER COMPUTER MODEL STUDIES WILL BE DEFINED FOR EACH SIDE'S CONTRIBUTION TO PHASE 3 OF THIS JOINT RESEARCH AND DEVELOPMENT PROGRAM.

U.S. INTERMEDIATE-SCALE TEST SITE. THE U.S. TECHNICAL MANAGER HAS LOCATED A SITE NEAR MAGDALENA (SOCORRO COUNTY), NEW MEXICO, THAT FULLY MEETS PLANNED TEST REQUIREMENTS. THE SITE IS A PRIVATELY-OWNED MINING COMPLEX, CONTAINING TWO TUNNELS, NAMED LINCHBURG AND PATTERSON MINES. THE TWO TUNNELS ARE SEPARATED BY A FEW HUNDRED METERS AND ARE JOINED AT THE REAR BY A LARGE, CAVERNOUS EXCAVATION. THE MINE IS CURRENTLY INACTIVE. THE TUNNELS ARE FAIRLY STRAIGHT, 2 METERS WIDE, 2 METERS HIGH, AND APPROXIMATELY 1,000 METERS LONG. THE GEOLOGY OF THE MINE COMPLEX INDICATES COMPETENT ROCK THROUGHOUT, ALLOWING THE EXCAVATION OF UNDERGROUND TEST CHAMBERS UP TO 5 METERS WIDE AND 3 METERS HIGH WITH A MINIMUM OF ROCK BOLTING OR OTHER REINFORCEMENT. THE TOPOGRAPHY IN THE VICINITY OF THE TUNNEL ENTRANCES, WITH A LARGE HILL ACROSS FROM A SMALL CANYON, WILL PROVIDE OPPORTUNITIES TO MEASURE EXTERNAL BLAST OVER MOUNTAINOUS TERRAIN. (THE U.S. HAS RECENTLY SECURED A ONE-YEAR LEASE ON THIS PROPERTY.)

VUGRAPH 19 (CONT)

REPUBLIC OF KOREA INTERMEDIATE-SCALE TEST SITE. THE REPUBLIC OF KOREA TECHNICAL MANAGER HAS SELECTED GEO-A ISLAND (PRONOUNCED GO-AAH), AN UNINHABITED ISLAND IN THE YELLOW SEA, APPROXIMATELY ONE HOUR OFF THE COAST, SOUTHWEST OF SEOUL. THE SITE IS ADJACENT TO ANHEUNG PROVING GROUND, AN AGENCY FOR DEFENSE DEVELOPMENT, ORDNANCE TESTING FACILITY. THE ISLAND WILL PROVIDE TWO SEPARATE TESTING LOCATIONS; ONE SITE CONSISTS OF A STEEP RIDGE INTO WHICH TEST CHAMBERS CAN BE BORED OR EXCAVATED; THE SECOND SITE WILL PROVIDE A MORE NATURAL TERRAIN AREA (HILLSIDE, CUL DE SAC), REPRESENTATIVE OF TYPICAL KOREA TOPOGRAPHY.

EXPECTED RESULTS

- SOLUTION TO AMMUNITION STORAGE SAFETY PROBLEM IN KOREA (UNDERGROUND STORAGE)
  - ALLOW CONFORMANCE WITH THE STANDARDS, REMOVING THOUSANDS OF U.S./ROK MILITARY AND CIVILIANS FROM RISK
- SOLUTION WILL ALSO PROVIDE BONUS BENEFITS:
  - APPLICABLE WORLDWIDE TO MANY U.S. ARMY NAVY, USAF SITES
    - -- MUCH GREATER SECURITY
    - -- MAJOR IMPROVEMENT IN SURVIVABILITY
    - -- ASSURED LONG-TERM COST SAVINGS

VUGRAPH 20

THIS PROGRAM WILL PROVIDE APPLICATIONS FAR BEYOND OUR AMMUNITION STORAGE IN KOREA. ALL OF OUR PAST STORAGE APPLICATIONS AND EXPLOSIVES TESTING CONDUCTED WITHIN THE DEPARTMENT OF DEFENSE, AND THE EUROPEAN COMMUNITY AS WELL, SUPPORTS THE EXPLOSION EFFECTS EXPERTS' CONSIDERATIONS THAT NEW UNDERGROUND STORAGE CONCEPT DESIGNS HAVE THE POTENTIAL TO SOLVE THE EXPLOSION PROBLEMS; AID IN BETTER SECURITY; PROVIDE FOR AMMUNITION SURVIVABILITY; AND RELATE TO COST SAVINGS BY REDUCING THE NEED FOR VALUABLE REAL ESTATE TO SATISFY SAFETY BUFFER ZONES, AS I MENTIONED IN THE BEGINNING. IT WILL ALSO REDUCE ASSOCIATED FACILITY COST INVESTMENT AND GAIN LONG-TERM SAVINGS.

EXPECTED RESULTS
(CONTINUED)

- SIGNIFICANTLY INCREASE SECURITY (INTRUSION, THEFT, OR SABOTAGE) WITH REDUCED MANPOWER AND REDUCE ASSOCIATED FACILITY COST INVESTMENT.

- PROVIDE ALL-WEATHER LOADING/UNLOADING ENVIRONMENT AND INCREASED SHELF LIFE OF AMMUNITION

- REDUCE VISIBILITY OF MILITARY PRESENCE AND PROVIDE COMPLETE PROTECTION AGAINST ENEMY SURVEILLANCE

VUGRAPH 21

THE LAST ITEM ON THIS CHART RELATES TO THE REPUBLIC OF KOREA PLACING GREAT EMPHASIS ON SURVIVABILITY OF THE AMMUNITION STOCK AS WELL AS SECURITY AND THE REDUCED VISIBILITY OF THE ACTIVITIES IN THE SOUTH FROM AN ENEMY.

CONCLUSION

- JOINT ROK/U.S. R&D PROGRAM TO PROVIDE NEW DESIGN CONCEPTS IS WELL UNDERWAY
- PHASE 2, SMALL-SCALE TESTING IS ON-GOING
- PHASE 3, INTERMEDIATE-SCALE TESTING IS BEING PLANNED
- PROGRESS TO DATE HAS BEEN EXCELLENT AND IS EXPECTED TO CONTINUE.

VUGRAPH 22

IN CONCLUSION - THIS JOINT RESEARCH AND DEVELOPMENT EFFORT IS EXPECTED TO RESOLVE MANY OF THE QUESTIONABLE TECHNICAL AREAS SUCH AS EXPLOSION CONTAINMENT, DEBRIS THROW, BLAST OVERPRESSURE MEASUREMENT, AND PREDICTIONS AND GROUND SHOCK APPLICATIONS. THE PROGRAM IS WELL UNDERWAY. SEVERAL OF THE RELATED ACTIVITIES OF PHASE 2 ARE BEING PRESENTED AT THIS SEMINAR BY MESSRS. KIM DAVIS AND CHARLES JOACHIM, WATERWAYS EXPERIMENT STATION, AND DRS. LEE AND SONG OF THE REPUBLIC OF KOREA AGENCY FOR DEFENSE DEVELOPMENT.

PLANNING, AS I INDICATED, FOR THE INTERMEDIATE-SCALE TESTING IS ON-GOING. BOTH THE U.S. AND REPUBLIC OF KOREA TECHNICAL MANAGERS INTEND TO VISIT THE U.S. PROPOSED TESTING SITE IN NEW MEXICO FOLLOWING THIS SEMINAR.

WE ARE EXCITED ABOUT OUR JOINT EFFORTS AND FULLY EXPECT GOOD RESULTS WHICH CAN BE SHARED WITH THE ENTIRE EXPLOSIVES SAFETY COMMUNITY. THE SUCCESS OF OUR FIRST THREE TECHNICAL ADVISORY GROUP MEETINGS SUPPORTS OUR CONTENTION THAT WE ARE PROGRESSING WELL.

THANK YOU!